COMBINE CUTTING AND FEEDING MECHANISMS IN THE SOUTHEAST

By J. K. Park

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CONTENTS

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The combine harvester has three distinct functions: cutting and feeding, threshing, and separating and cleaning. The first is generally the most difficult to accomplish satisfactorily. The combine has been developed and improved through the years to the point where it threshes and cleans most crops efficiently, but the cutting and feeding operation is often far from satisfactory. This is particularly true in crops whose seeds shatter easily, very short or very tall crops, lodged crops, and crops that are difficult to cut.

The purpose of this report is to review research conducted from 1954 through 1961 on various aspects of the problem of cutting crops and feeding them into the combine harvester. The studies were conducted by the Agricultural Engineering Research Division, Agricultural Research Service, U.S. Department of Agriculture, in cooperation with the South Carolina Agricultural Experiment Station, Clemson, S.C.

For a further discussion of seed harvesting in the Southeast, including some of the cutting problems referred to herein, refer to South Carolina Agricultural Experiment Station Bulletin 461(6).

HARVESTING METHODS

There are three basic methods of harvesting seeds and grains. The first of these—commonly referred to as direct combining—is to cut and feed the standing crop directly into the combine. The crop is cut with the combine's cutterbar and feeding is done by one or more of several devices mounted on the header, including reels, augers, drapers, and conveyor chains. The second method—commonly referred to as swath, or windrow, harvesting—is to mow the crop and, usually, gather it into a windrow and then pick it up and thresh it with the combine. A pickup attachment is mounted on the header to pick up the swaths, or windrows. The third method is to carry the crop to a stationary thresher or combine. This method is still used for harvesting small seeds in some western areas. It is not used in the Southeast; therefore, it is not discussed in this report.

THE CUTTERBAR

The most important operation in cutting and feeding crops to the combine is that of cutting the plants. This operation is essentially the same whether the crop is cut with a mower for windrowing or cut by the combine's cutterbar in direct combining.

The basic design of the combine cutterbar is essentially the same as that of the mower. This design has remained fundamentally unchanged since the early 1830's, when the cutterbar with stationary guards and a reciprocating sickle (fig. 1) was developed to a point where it was successfully used on the reaper.

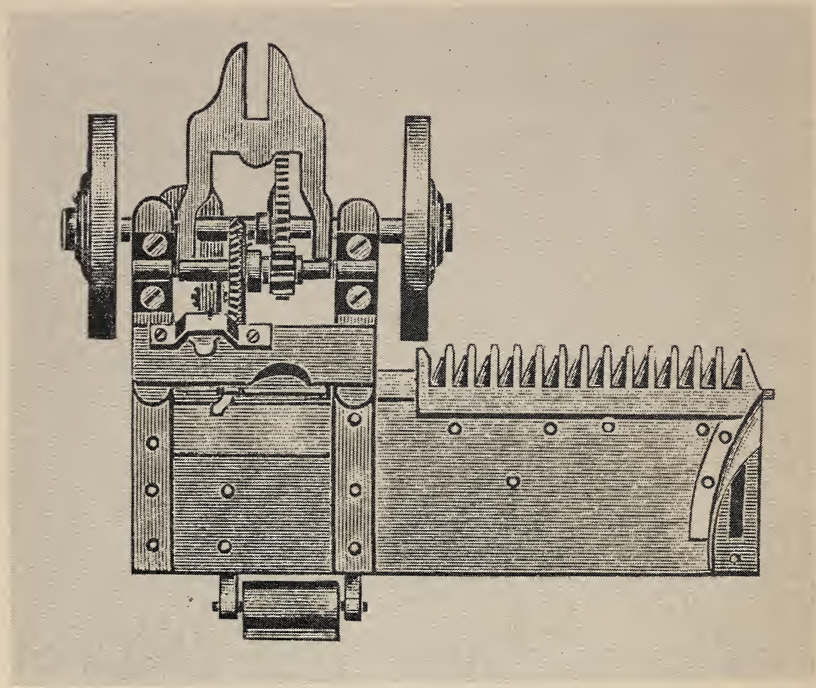

FIGURE 1.—Cutterbar with stationary guards and reciprocating sickle used on one of the earliest machines. (Courtesy of the Farm Equipment Institute.)

Experimentation with details of design of the cutterbar has been in progress since its inception and is still in progress. Much progress has been made by the farm-machinery manufacturers in developing effective cutterbars.

In appraising the performance of the cutterbar, two fundamental criteria must be considered. These are the percentage of the grain or seed lost in the cutting operation and the effectiveness in cutting plant material. Both of these are influenced not only by the cutting action but also by other mechanisms on the header that assist in the feeding operation.

Cutterbar Losses

Many measurements of cutterbar loss have been made in direct combining various crops at Clemson, S.C. The following figures illustrate that important quantities of seed and grain are lost at the cutterbar. Cutterbar losses averaged about 13 percent in crimson clover, 28 percent in fescue, 25 percent in Kobe lespedeza, 14 percent

in sericea lespedeza, 16 percent in combine peas, 14 percent in rescue, 15 percent in sesame, and 8 percent in soybeans. These figures are for cutterbar loss only; they do not include weather shatter losses before harvest, which are often as great as these cutterbar losses, if not greater.

Several distinct types of loss occur at the cutterbar. The first and often greatest of these is from shattering of seed from the plant ahead of the cutterbar. This loss may result from the action of the cutterbar or the reel or both. Many of the seed fall directly onto the cutterbar and then, because of the vibration and forward slope of the sickle, slide forward and fall to the ground. Such loss of shattered seed is often serious in many of the grasses and small-seeded legumes. such as fescue and lespedeza; but loss is usually not significant in the grains.

A local farmer developed a seed-salvage attachment to reduce this loss when harvesting lespedeza. The attachment consisted of an auger mounted under the sickle that salvaged seed falling through slots directly behind the sickle. Several tests of this attachment in fields near Clemson showed that it increased harvested yield of lespedeza by 10 to 25 percent. Although this attachment was developed in 1953, it has never been made commercially available.

The second type of cutterbar loss consists of seed or grain that is too close to the ground for the cutterbar to reach. This loss is most serious in short-stemmed crops or under any crop condition where much of the grain or seed is close to the ground at harvesttime. It may also be serious in crops that set seed well above the ground but become lodged at harvesttime. Observation of many soybean fields being harvested in South Carolina showed that combines were sometimes operated with their cutterbars leaving many of the beans untouched on the stubble. Short stems with beans too close to the ground, rough ground, and difficulty in keeping the cutterbar close to the ground all contributed to loss of beans in this manner. For a complete discussion of soybean harvesting losses in South Carolina, most of which are cutting losses, refer to South Carolina Agricultural Experiment Station Circular 123 (*7*).

The third type of cutterbar loss results from plants or branches falling ahead of the cutterbar after being cut by the sickle. This loss is not significant in most crops and under most conditions. However, sometimes it may be quite large. In sesame, for example, measurements have shown as much as 15 percent of the seed lost on whole stems or branches in this manner, and loss of 10 or 15 percent of soybeans on branches falling ahead of the cutterbar is not uncommon. Losses of this type also occur under some conditions in grain sorghum and small grains.

The fourth type of cutterbar loss results from plant material pushing ahead of or bunching on the cutterbar. This is caused by poor cutting or feeding action or both. In most crops loss from this is small. However, in some instances this becomes a most aggravating problem and causes considerable loss of seed. Such conditions may result from very light stands, where the amount of material is insufficient to maintain a continuous flow over the cutterbar, or in very heavy stands, where the crop is difficult to cut.

The fifth type of cutterbar loss results from shattering or trampling by the outside divider. Some seed or grain is always lost at the outside divider, but the amount is usually small. However, under some conditions, especially with seeds that are easily shattered, this loss may become considerable. In alfalfa fields in the West, this problem is often solved by mounting a short vertical sickle on the header to separate the crop at the outside divider.

These five types of cutting losses refer primarily to losses in direct combining. However, similar losses occur when the crops are harvested by mowing and windrowing and then picking up the windrows with a pickup attachment on the combine. With this method, seed losses occur both in mowing and windrowing and in picking up the windrows and feeding them into the combine. In tests at Clemson comparing windrow harvesting with direct combining, total cutting and feeding losses were usually greater with the windrow harvest method. These losses were sometimes offset by smaller weather shatter losses from the windrow harvest method. Direct combining usually proved to be the best method of harvesting seed crops in this area.

Factors Affecting Cutterbar Performance

Many factors may influence cutting and feeding of crops into the combine. Conditions are never exactly the same in any two fields or even in different places in the same field. Therefore, the combine header is required to operate effectively under many diverse conditions—obviously a difficult requirement. Some of the factors that have been observed to influence the cutterbar performance follow.

Growth characteristics of the crop.—Since different crops vary widely in growth characteristics, such as height and type of plant, they may present entirely different problems in cutting and feeding. Similarly, wide variations in different varieties, different fields, and different geographic locations affect growth characteristics of a given crop.

Conditions at harvesttime.—These conditions include stage of maturity and moisture content of the crop, atmospheric conditions, and prevalence of weeds. Clean and uniform stands of crops in good fields are normally much easier to harvest efficiently than are weedy, nonuniform crops in poor fields. Most crops are easiest to cut and feed into the combine if harvested at the optimum stage of maturity. If harvested while too green, they are sometimes difficult to cut; and if overripe, they often lodge and cause excessive cutting losses. The influence of atmospheric conditions is evidenced by the fact that cutting is usually more difficult in early morning, late afternoon, or after a rain.

Smoothness of ground surface.—Rough ground makes close cutting impossible; therefore, in low-growing crops, such as crimson clover and lespedeza, the land surface should be left as smooth as possible at planting time to avoid excessive losses from having to carry the cutterbar too high when harvesting. Rocks in the field also affect the closeness with which the crop can safely be cut without getting rocks into the cylinder. The use of a cultipacker in planting often helps considerably with this problem by pushing exposed rocks into the ground.

Design of the cutterbar.—The design of the cutterbar and the overall design of the header and its components greatly affect cutting effectiveness. Cutterbar design factors include guard shape and spacing, sickle section shape and serration, sickle speed, and overall configuration of the cutterbar. Header and components design factors include type and design of reel, design of auxiliary feeding components such as drapers or feed augers, overall configuration of the header, flotation of the header, and method of driving the reel. Some of these header components vary considerably among the different combines; as a result, various headers often differ in performance even when used side by side in the same field. Specific observations and test results regarding some of these factors are given later in this report.

Control of the cutterbar height.—Accurate control of the cutterbar height is an important consideration, particularly with low-growing crops that must be cut close to the ground. Such accurate control is more difficult as headers become wider and heavier. Some of the older headers could be controlled more accurately than headers on newer combines because they were narrower and lighter and could be operated by hand. The use of feed augers to replace drapers has contributed to heavier headers. The weight or inertia of the header is important in close cutting because the light header can react more readily to force on the cutterbar from ground irregularities, rocks, or obstructions. Under many conditions a light header can be allowed to float or slide along the ground surface.

On combines equipped with a header counterbalance, the spring should be adjusted so that the header rides as lightly as possible. If the spring is adjusted so considerable force is required to lift the header, excessive damage to the cutterbar may occur when low-growing crops are being harvested in rough or rocky fields.

The cutterbar height can usually be maintained more accurately on power takeoff combines than on self-propelled combines, because the cutterbar is located between, rather than ahead of, the wheels that affect its height. This placement results in a simpler job of hydraulic control manipulation by the operator.

Care and skill of the operator.—The last, but not least important, factor affecting cutterbar performance is the care and skill of the operator. To obtain satisfactory performance, the operator must maintain the entire header in proper condition and must use care and judgment in its operation.

Special Cutterbar Equipment

Various special cutterbar equipment is sometimes used in specific situations to reduce cutting loss or to improve cutting performance. This includes such items as special guards or sickles, cutterbar extensions, and lifter guards.

Of these, lifter guards such as those shown in figure 2 are used most commonly. Lifter guards of some sort are available for all cutterbars. They attach to the standard guards, and their purpose is to lift onto the cutterbar any plants or branches that the cutterbar would otherwise pass above. They reduce cutting loss considerably in some situations and in others are of little value, or even detrimental. Usually

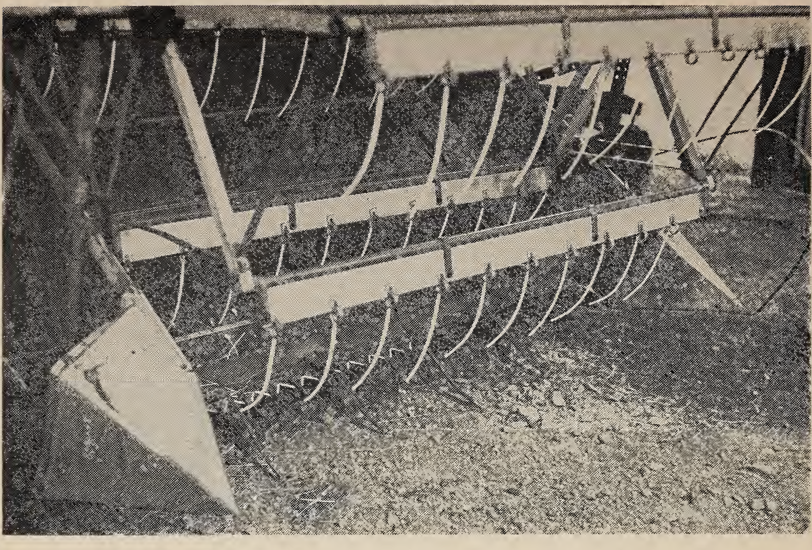

FIGURE 2.—Lifter guards used primarily for harvesting lodged crops.

their effectiveness cannot be predicted without actually trying them out.

Lifter guards were tested under several field conditions at Clemson, usually in lodged crimson clover. Table 1 shows the result of one of these tests. For treatment 1, the standard cutterbar and tined reel were used. For treatment 2, lifter guards were attached to the cutterbar. The use of the lifter guards resulted in a highly significant (0.01 level) increase in harvested yield. These guards were also observed to be of definite value under some conditions in soybeans.

TABLE 1.—*Effect of lifter guards on harvested yields of lodged crimson clover, Clemson, S.C., 1957*

Treatment	Yield, pounds per acre [1]										
	Replication No. —										Average
	1	2	3	4	5	6	7	8	9	10	
Standard cutterbar	154	154	125	135	136	117	152	131	124	92	132
Lifter guards	170	169	158	144	142	131	162	145	138	133	149

[1] Least significant difference: at 5-percent level, 8.05; at 1-percent level, 11.57.

Basic Cutterbar Designs

From the foregoing discussion it is obvious that the present cutterbar under many circumstances does not perform its intended function so effectively as would be desired. Therefore, throughout the history

of the cutterbar many attempts have been made to develop other basic designs that would be more effective than the one now used. This is evidenced by the voluminous file of cutterbar patents in the U.S. Patent Office.

One of the primary objectives of this project has been to search for alternate combine cutterbar designs that might prove more effective than the one now used. This search has included a study of relevant developments throughout this and other countries, as well as research on experimental designs. Most major manufacturers of farm machinery have made studies of alternate basic cutterbar designs. However, no design that has proved to be more practical than the one now used has resulted from these studies.

Some of the alternate ideas that have been tried include the use of rotating blades, chain-saw type mechanisms, strippers, and flailing devices. These may be classed as designs that would be used in lieu of the reciprocating sickle and guard. Other designs are essentially modifications of the sickle and guard; one of these is the double sickle, which replaces the guards with a second reciprocating sickle.

Cutterbar Research

Much research has been conducted regarding the effect of design variations on the cutting action of the standard reciprocating-sickle cutterbar. Such experimentation has been done by manufacturers of farm machinery, research agencies, and private investigators.

Energy requirements in relation to knife velocity—when a counteredge was used and when one was not used—have been studied. Energy requirements were not affected by velocity when a counteredge was used (*4*). Energy requirements increased with velocity when a counteredge was not used when tall plants were cut; this increase was caused by the greater energy transmitted to the tops of the plants (*2*). With smooth knife edges, the lowest energy requirements were obtained with a knife angle of 60° when a counteredge was not used (*2*) and with an angle between 17° and 25° when a counteredge was used (*5*). Optimum cutting performance and minimum wear occurred when a 24° bevel angle was used (*3*). Energy requirements were lowest when the gap between knife and counteredge was held to a minimum (*5*).

Several studies related to cutterbar action and performance have been made at Clemson. In addition to many measurements of shatter loss, these studies included observations of the effects of type of guard, guard spacing, blade serration, chrome-plated blades, a double sickle bar, slides for header flotation, and header spring tension.

A cutterbar was equipped with slender guards on one-half its length and thick guards on the other to study the effect of guard cross section. Under the particular conditions of this test no difference in the cutting action of the two halves was observed. However, performance of various cutterbars under other conditions has indicated that those with slender guards cut more cleanly than those with thick guards.

Regular guards (3-inch spacing) were compared with lespedeza guards (1½-inch spacing) in several lespedeza fields. In every such

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comparison the regular guards cut much better than the lespedeza guards, and serious troubles were sometimes caused by the lespedeza guards. The lespedeza guards did not show any apparent advantage under these conditions.

Comparisons of chrome-plated with standard sections and serrated with standard sections were made. Sections of the two types were installed on the two halves of the cutterbar. Under the conditions of these tests no differences in the cutting action of the different types of sections were observed. However, the effects vary widely with conditions and their influences are important under some conditions. The sections used in these tests were new; different results might have been obtained if the cutterbar had been subjected to considerable wear before testing. In other tests, chrome-plated sections have been found to wear better and retain sharpness longer.

Special sickle sections with tungsten carbide cutting edges were tested by extensive use on a mower sickle. Alternate sections on a new sickle were replaced with these special sections. The mower was used to cut approximately 100 acres of pasture. During this time, five of the regular sections had to be replaced but only one of the special sections. The sickle was sharpened three times. At these times the regular sections were found to be dull but the special sections were still sharp.

A double sickle bar mower (fig. 3) was compared with a standard mower under several field conditions. Under some conditions the double sickle bar proved definitely superior to the standard bar. For example, in one field of johnsongrass the double sickle bar cut cleanly but the standard bar caused excessive clogging. A similar observation was made in Oregon,[1] where the double sickle bar performed well

FIGURE 3.—Mower with two reciprocating sickles used in some of the tests.

[1] Unpublished studies by Jesse Harmond, Harvesting and Farm Processing Res. Branch, Agr. Engin. Res. Div., Agr. Res. Serv., U.S. Dept. Agr. Ann. Rpt. 1959. [Typed Rpt.]

in subterranean clover, which was practically impossible to cut with a standard mower. In Coastal bermudagrass and crabgrass some trouble was encountered with the double sickle bar because stems lodged between the two blades. The double sickle bar also left a ragged appearance under some conditions, particularly in grasses, as a result of unevenness in length of cut stubble. The sickle bar also suffered more damage in rocky fields.

There is often a marked difference in the way individual cutterbars perform when cutting close to the ground. The performance may be influenced by small obstructing parts in the vicinity of the sickle, forward slope of the cutterbar, position of the cutterbar with respect to other header components, height of the sickle when the header is resting on the ground, and many other details of construction of the cutterbar and header. It is also influenced by the inertia and balancing of the header. Because of the practical importance of these construction details, experiments have been conducted at Clemson in an attempt to improve close cutting performance of some headers under specific conditions. These experiments have consisted primarily of testing the effectiveness of various types of slides attached below and behind the cutterbars to enable closer cutting without the cutterbar digging into the ground. Some of these attachments have been effective.

FEEDING COMPONENTS

Various types of feeding devices are used on the combine header to assist in feeding material to the threshing cylinder. These include reels—which assist in feeding material to the cutterbar—and various combinations of augers, drapers, conveyors, and feed cylinders—which contribute to the flow of material from the cutterbar to the threshing cylinder. The action of the cutterbar itself is often decidedly affected by the action of the feeding components, particularly the reel.

Tined and Bat Reels

Two types of reels are commonly used: the bat-type reel and the pickup, or tined, reel (fig. 4). The bat-type reel is the one most commonly used, especially in the Southeast. Perhaps the reason for this is that it is the least expensive and is usually offered as standard equipment on the combine.

These two types of reels were compared in several controlled tests at Clemson. Usually the tined reel proved to be decidedly superior. The tined reel often resulted in trouble-free cutting in fields where reel wrapping, cutterbar clogging, or other cutting troubles occurred when the bat reel was used. The more positive action of the tined reel in moving material across the cutterbar usually accounted for this difference.

The tined reel usually resulted in a considerably more uniform flow of material to the threshing cylinder. This reduced slugging and the loss of unthreshed seed that occurs when material accumulates at the cutterbar and is fed to the cylinder in bunches.

The greatest advantage of the tined reel over the bat reel was that usually the loss of seed at the cutterbar was considerably less. The primary reason for this was that there was usually less shattering of

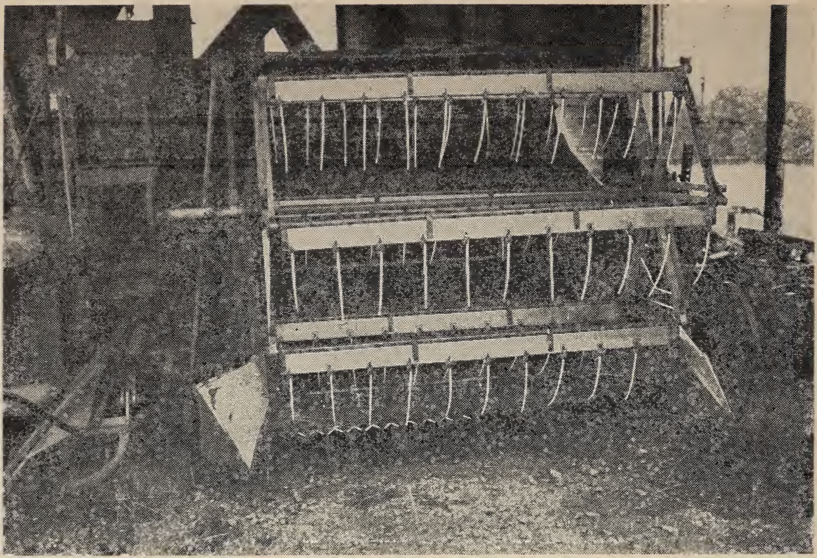

FIGURE 4.—Tined reel used in several tests at Clemson, S.C.

seed ahead of the cutterbar because the cutterbar was kept cleaner by the more positive action of the tined reel. Another reason was the smaller loss of plants and branches at the cutterbar because of the superior cutting action when the tined reel was used.

Eighteen separate tests were conducted to compare the tined reel with the bat reel under different conditions and with various crops, including crimson clover, fescue and rescue grasses, and Kobe and sericea lespedeza. The results of these tests varied from no significant difference in harvested yields to as much as 7 percent more yield with the tined reel than with the bat reel. In practically all tests the action of the tined reel was judged to be superior; in the majority of tests a larger harvested yield was obtained when the tined reel was used, although the difference was not always statistically significant.

Table 2 shows the results of a test in crimson clover in which the tined reel was compared with the bat reel. In this test the reel was

TABLE 2.—*Effect of bat and tined reel on harvested yield of crimson clover, Clemson, S.C., 1954*

Treatment	Yield, pounds per acre [1]								
	Replication No.—								Average
	1	2	3	4	5	6	7	8	
Bat	385	426	358	336	390	372	368	335	371
Tined	413	427	375	372	391	367	406	371	390

[1] Least significant difference: at 5-percent level, 15.18; at 1-percent level, 22.46.

changed after each replication, alternating the two types of reels. A significantly higher harvested yield was obtained when the tined reel was used.

Reel Drives

Two methods are commonly used for supplying power to drive combine reels. One is to take power from the power source that supplies the combine and the other is take power from the ground. The ground-driven reel maintains a peripheral speed that is in constant relation to ground speed, while the speed of the power-driven reel is independent of ground speed. In the tests conducted on this project the ground-driven reel frequently had a definite advantage, but under no situation did the power-driven reel appear to be preferable. Excessive shattering frequently resulted from power-driven reels because of the inability of this type reel to maintain proper speed relative to the ground. This consideration is especially important in crops whose seeds shatter easily.

Reel Attachments

Several attachments and modifications are available for bat reels. These include additions to prevent plants from wrapping around the ends of the reel or around the bats, variations in the number of bats, and belting or brushes attached to the bats to wipe seed off the cutterbar. The need for such attachments can only be determined by the performance of the reel in a specific field condition. Several such reel attachments have been used in special situations at Clemson and have proved of value in some cases. Belting strips attached to the bats to wipe seed from the cutterbar proved of definite value under some conditions where considerable seed was shattered onto the cutterbar and in very light stands to prevent plants from falling to the ground ahead of the cutterbar. In a light stand of fescue at Clemson where considerable seed was being lost over the cutterbar, strips of belting attached to the reel bats increased harvested yield by 25 percent.

The Wind-Reel [2]

A Wind-Reel attachment for combine headers has been used in harvesting barley in Montana (*1*). One of these Wind-Reel attachments (fig. 5) was obtained for testing under Southeastern conditions. It was compared with standard bat and tined reels in small-seeded crops, including crimson clover, fescue and rescue grasses, and Kobe, sericea, and Korean lespedeza. In all these crops the Wind-Reel appeared to perform as well as or better than either the bat or tined reels; under some conditions a considerably higher harvested yield of seed was obtained with the Wind-Reel. For example, the use of the Wind-Reel resulted in a 21.3 percent increase in harvested yield of sericea lespedeza in one test and a 23.5 percent increase in harvested yield of fescue in another test (tables 3 and 4). Both of the increases were highly significant (0.01 level). The most pronounced increase

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[2] Mention in this publication of commercially manufactured equipment does not imply endorsement by the U.S. Department of Agriculture over similar equipment not mentioned.

in harvested yield was in a field of very short Kobe lespedeza, where the Wind-Reel harvested more than twice as much seed as a standard bat reel on another combine.

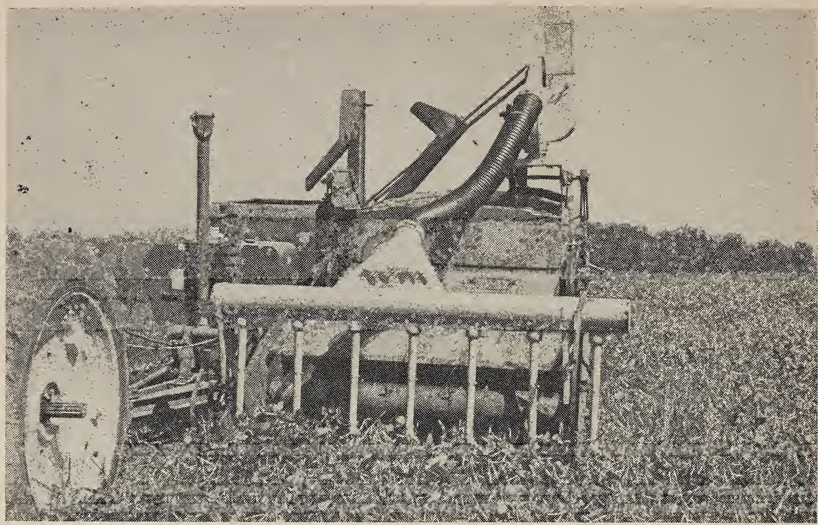

FIGURE 5.—A combine equipped with a Wind-Reel, which utilizes air blasts to move crop material over the cutterbar.

TABLE 3.—*Effect of the Wind-Reel on harvested yield of sericea lespedeza, Clemson, S.C., 1958*

Treatment	Yield, pounds per acre [1]					
	Replication No. —					Average
	1	2	3	4	5	
No reel	68	54	52	37	33	48. 8
Wind-Reel	77	69	58	54	39	59. 4

[1] Least significant difference: at 5-percent level, 6.3; at 1-percent level, 10.5.

TABLE 4.—*Effect of the Wind-Reel on harvested yield of fescue, Clemson, S.C., 1958*

Treatment	Yield, pounds per acre [1]				
	Replication No.—				Average
	1	2	3	4	
No reel	145	132	139	147	140. 5
Wind-Reel	166	165	180	182	173. 5

[1] Least significant difference: at 5-percent level, 13.5; at 1-percent level, 24.8.

The increases in harvested yield with the Wind-Reel in these crops were caused by reductions in loss of seed shattered by the cutterbar. The blast of air carried the seed onto the platform and prevented shattered seed from falling to the ground ahead of the cutterbar.

Because of the increases obtained in the small-seeded crops, tests were conducted in other field crops commonly harvested with combines in this area, including wheat, oats, barley, rye, soybeans, and combine peas. In all tests the Wind-Reel did an excellent job of keeping the cutterbar clean and no cutting trouble was encountered. Therefore, it was concluded that the Wind-Reel might prove very satisfactory as a general-purpose reel. However, the Wind-Reel is considerably more expensive and more complicated than the reels now used; hence, from a practical standpoint the advantages would have to outweigh the additional cost and mechanism involved.

Drapers and Feed Augers

Up until about 1960 canvas drapers were used on most combines to feed material from the cutterbar to the threshing cylinder. A feed cylinder or short draper is usually used above the top of the main draper on these machines to assist in feeding material to the threshing cylinder. Now (1962) most manufacturers have abandoned the draper in favor of other devices, usually including a feed auger with disappearing fingers and a feeder conveyor chain. Cut material is removed from the cutterbar by the auger and then carried onto the threshing cylinder by the conveyor chain.

From observation of these two general types of feeding in tests in South Carolina, it is difficult to judge which has usually proved the most effective. The canvas drapers require occasional replacement and give trouble under some conditions. However, the headers using augers and feed chains are usually considerably heavier, and, therefore, are inherently less able to cut close to the ground because they are less sensitive to forces that occur when they inadvertently touch the ground.

Flax Rolls

Two tests were conducted in crimson clover to see if the use of flax rolls would improve the efficiency of the threshing cylinder. The results were inconclusive. Although unthreshed seed loss averaged slightly less when the flax rolls were used, the difference was not statistically significant and it appeared that any actual improvement in threshing was small. The results certainly indicated that any advantage gained was too small to recommend the use of flax rolls to the crimson clover growers in the Southeast. However, the flax rolls did provide positive insurance against the possibility of any sizable rocks entering the combine cylinder.

Row-Crop Attachments

Combine harvesting of row crops, such as grain sorghum and soybeans, often presents feeding problems—usually excessive loss of plants or clipped branches—not encountered in the cutting and feeding of broadcast-seeded crops. Therefore, special header attachments are sometimes used in harvesting these crops.

One such attachment developed and tested at Clemson for harvesting soybeans was an adaptation of the Wind-Reel (fig. 6). Blasts of air were directed on each side of the plant as it entered the cutterbar, which blew the plant immediately onto the header. This feeding method proved highly effective in the tests conducted.

FIGURE 6.—A modified Wind-Reel used for harvesting soybeans.

The headers of present combines cannot harvest corn and, as mentioned earlier, are often not completely satisfactory for harvesting other row crops. Corn header attachments now available are effective but relatively expensive. The need for a simple header attachment that enables the grain combine to harvest corn as well as to improve its effectiveness in other row crops was seen.

A row-crop header attachment was developed and tested during 1959 through 1961 to meet this need (fig. 7). This attachment is light and simple and can be easily mounted on most of the current-model combines. Shields position the plants and a disappearing-finger mechanism provides force to move them across the cutterbar. The unit was used on different power-takeoff and self-propelled combines to harvest about 125 acres of corn and smaller acreages of soybeans, grain sorghum, and sweet sorghum. Performance was usually very satisfactory. Ear losses were usually less than 3½ percent in standing corn, and cutting losses were very low in soybeans and grain sorghum. Ground speeds as high as 5.8 miles per hour were maintained in 100-bushels-per-acre corn, with clean grain in the bin and very small losses through the combine. Two units were mounted on one 12-foot header, which made it possible to harvest four rows at a time.

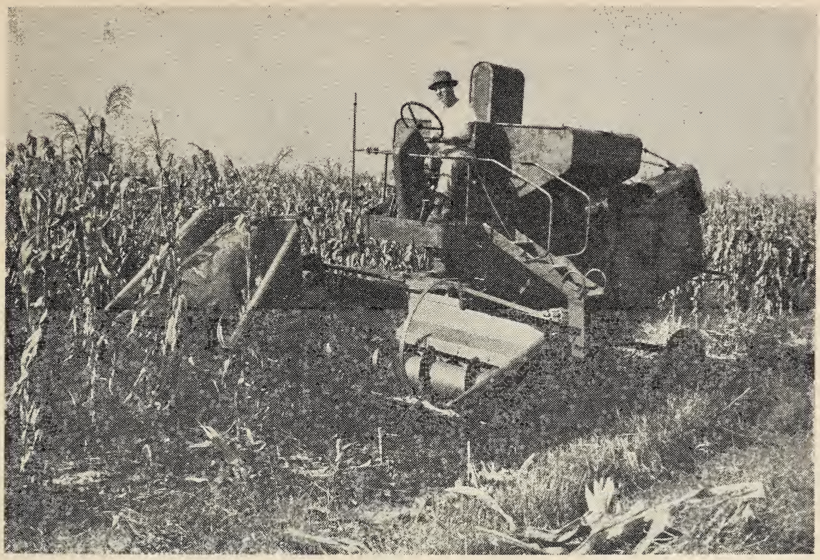

FIGURE 7.—Harvesting corn with a combine equipped with a simple header attachment developed to facilitate harvesting of corn and other row crops with the grain combine.

WINDROW HARVESTING

Direct combining from the standing crop is the method almost always used for harvesting seed or grain crops in the Southeast. The practice of windrow harvesting is rarely used.

Several tests were conducted near Clemson to compare these two methods of harvesting (*6*). Briefly, the conclusion from these studies is that, all factors considered, direct combining is the preferable method of harvesting the crops studied under most circumstances in this area.

The cutting and feeding problems are different in some respects when the windrow-harvest method is used. This method requires mowing, windrowing, and pickup equipment not required in direct combining. Seed losses may occur in each of these operations, and the total seed loss in windrow harvesting depends on circumstances—it may be either more or less than that in direct combining.

Windrowing Methods and Equipment

A large variety of equipment and techniques are used in the windrow method of harvesting seed crops. Sometimes swaths are mowed and left for a period of time, then raked into a windrow. Sometimes a windrowing, or "curling," attachment is mounted directly onto the mower. Swathers, or windrowers, of various designs are used. These machines (fig. 8) mow and windrow the crop in one operation. Self-propelled swathers are becoming increasingly popular in the western section of the country.

FIGURE 8.—Harvesting crimson clover with a machine that mows and windrows in one operation.

In tests of windrow harvesting at Clemson it was usually found to be preferable to leave the crop in an undisturbed swath rather than to gather it into a windrow, because it took the windrows too long to dry enough to harvested. A Roto-Windrower (fig. 9), patterned after a machine developed in Canada (*8*), proved of value because it provided a practical compromise between an undisturbed swath and a windrow. It gathered material just enough to insure efficient pickup and still left enough spread to eliminate the problem of slow curing encountered with the windrow.

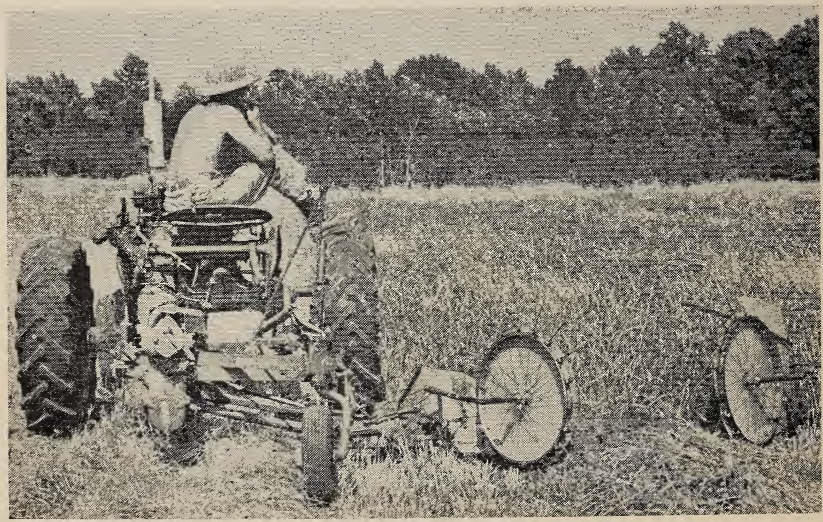

FIGURE 9.—Roto-Windrower used to mow swaths for the windrow method of harvesting.

Other tests of windrow harvesting at Clemson showed that increased harvested yields were obtained by mowing while the plants were damp with dew. Usually greater yields were also obtained by picking up against the heads rather than against the butts. These are well recognized as proper procedures.

Windrow Pickup Attachments

In harvesting windrows the combine header is usually equipped with a windrow pickup attachment. Three basic designs are used for pickup attachments: The draper-type, the raddle-type, and the drum-type. In all three designs flexible steel fingers revolve into the bottom of the windrow and carry it over the top of the attachment.

The draper-type attachment (fig. 10.) is usually preferred for crops whose seed shatter easily, because the moving draper carries shattered seed on back into the header. Tests at Clemson showed that loss of shattered seed was appreciably higher with the raddle-type and drum-type than with the draper-type.

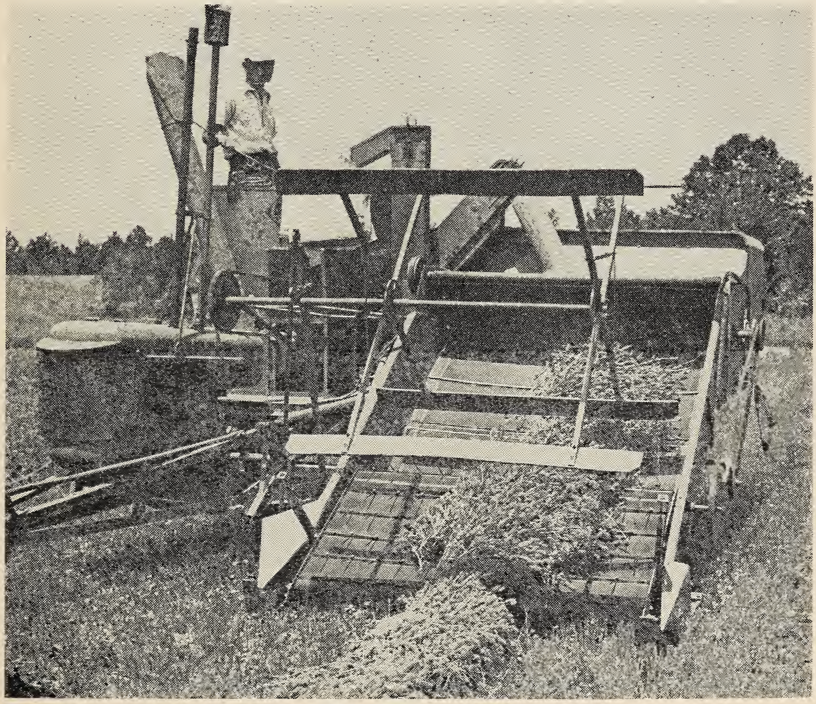

FIGURE 10.—Combining crimson clover from the windrow with the draper-type pickup attachment.

Another method of picking up windrows, or swaths, is to use the standard header equipped with a tined reel (fig. 11). The cutterbar is left in operation when this is done. This method was compared with the use of pickup attachments in several crops and under various conditions at Clemson. In some cases it proved to be even more effective than the use of pickup attachments. It was most effective when the crop was harvested fairly soon after mowing, while seed heads were still well above ground level. It was unsatisfactory if rain occurred between mowing and harvesting, because seed heads were beaten to the ground and could not be picked up. The practice was particularly useful for harvesting weedy or green areas, which could not be effi-

ciently direct combined. Such areas could often be mowed in the morning and harvested quite satisfactorily the same afternoon or the next day with considerable improvement in harvesting efficiency. In appropriate circumstances such a procedure could be used quite effectively by farmers. If the combine is equipped with a tined reel, no other equipment is needed or no changes are necessary on the combine to alternate between this procedure and direct combining.

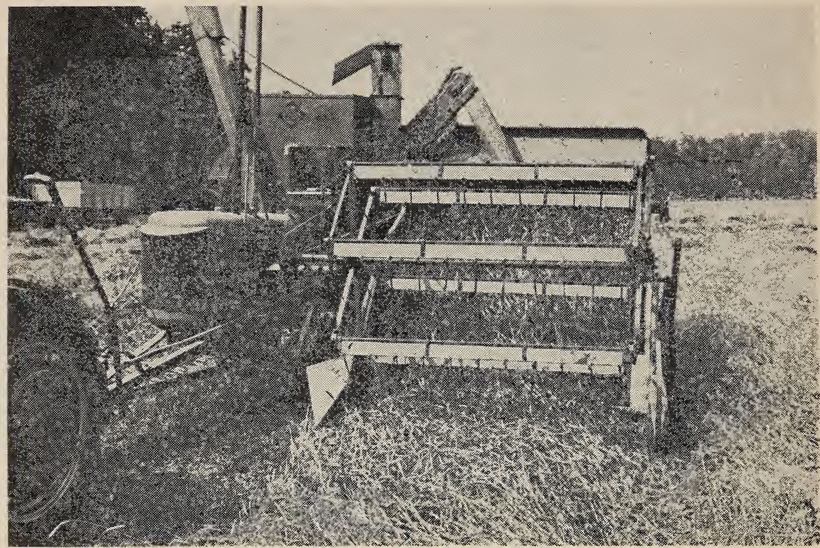

Figure 11.—The standard header equipped with a tined reel being used to pick up swaths.

SUMMARY

Seed crops in the Southeast are usually harvested from the standing crop; a small acreage is harvested from the windrow.

The reciprocating-sickle cutterbar used on the combine and on the mower has remained unchanged in fundamental design since the early 1830's, although many improvements have been made in design details and performance.

Average cutting losses with direct combining in the seed crops harvested in these studies ranged from 13 percent in crimson clover to 28 percent in fescue. Losses were caused by seed shattering ahead of the cutterbar, seed too low to be cut, branches or plants falling ahead of the cutterbar, trampling or shattering by the divider, and bunching of material on the cutterbar.

Tined pickup reels proved definitely superior to the bat-type reel in most of the comparisons in a number of crops at Clemson.

Ground-driven reels were preferable to power-driven reels under most conditions.

The Wind-Reel substantially reduced shattered seed loss in some crops and performed effectively in all the crops tested.

A simple row-crop header attachment developed as part of these studies proved effective and of potential value.

A basically new and better cutting principle will have to be devised if cutting losses are to be substantially reduced. Thus far, the many attempts to do this must be considered unsuccessful. Continued efforts should be made, for such a development would be a valuable contribution to agriculture.

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